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CAST instrument in epidemiological surveys: Results presentation in comparison to the WHO criteria

Uso do instrumento CAST em levantamentos epidemiológicos: apresentação dos resultados em comparação ao critério da OMS

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Abstract *Caries Assessment Spectrum and Treatment (CAST) is an instrument developed for caries detection to be used in epidemiological surveys; it has been validated and is believed to provide a clearer picture of the oral health status than the criteria provided by the World Health Organization (WHO). This article aims to compare the epidemiological survey results using the CAST instrument and the WHO criteria in the same population. 680 schoolchildren aged 6-8 years from Federal District, Brazil, were evaluated by two examiners trained to use the CAST. The visible plaque index (VPI) and gingival bleeding index (GBI) were also evaluated. The maximum CAST codes per tooth were converted into the dmf/DMF, the mean scores for primary and permanent dentition were calculated. The mean age was 7.45(± 0.91) years. The prevalence of caries differed when CAST and the WHO criteria were applied. In the primary dentition, it was 65.44% and 61.61%, and for the permanent dentition, 38.19% and 10.2%, respectively. It was possible to calculate the mean dmft [2.4(± 2.7)] and the DMFT [0.16(± 0.53)] using CAST. VPI was associated with higher maximum CAST scores p < 0,005. The way CAST results are presented showed a higher sensibility to identify the presence and severity of carious lesions in comparison to the WHO criteria.*
Key words *Dental caries, CAST, Caries epidemiology*

Resumo *O CAST (Caries Assessment Spectrum and Treatment) é um instrumento desenvolvido para a detecção de cárie a ser utilizado em levantamentos epidemiológicos. Foi validado e tem se mostrado efetivo, fornecendo um diagnóstico mais preciso do estado de saúde bucal do que o critério OMS, recomendado pela Organização Mundial da Saúde. O objetivo deste artigo é comparar a apresentação dos resultados de cárie dentária utilizando o instrumento CAST e o critério OMS, numa mesma população. Foram avaliados por dois examinadores treinados na utilização do instrumento CAST 680 escolares de 6 a 8 anos do Distrito Federal, Brasil. A avaliação constou do índice de placa visível (IPV) e do índice de sangramento gengival (ISG). Os escores CAST dente foram convertidos em componentes ceo/CPO e calculados os ceod/CPOD. Os pais responderam a um questionário sociodemográfico. A idade média foi 7,45 anos (± 0,91). A prevalência de cárie na dentição decídua foi de 65,44% e 61,61%, considerando o CAST e o critério da OMS, respectivamente; na dentição permanente: 38,19% e 10,2%, respectivamente. A média do ceod foi de 2.4 (± 2.7) e a média do CPOD 0.16 (± 0.53). o IPV foi associado a maiores CAST máximos p < 0,005. O instrumento CAST demonstrou maior sensibilidade em identificar a presença e gravidade de lesões cariosas quando comparado ao critério OMS.*
Palavras-chave *Cárie dentária, CAST, Epidemiologia da cárie*

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Introduction

For years, researchers have been seeking an improved and easy-to-use instrument for conducting standardized epidemiological surveys, which is also designed to support subsequent action planning and implementation[1]. Given the impact of dental caries in people's life, it is essential that these surveys generate useful information for public health action planning and comply to national policies[2]. However, the instruments available for carrying out epidemiological surveys on dental caries do not adequately address the entire spectrum of the disease (either they do not include initial states of dental caries or their not able to provide information about caries severity). This deficit might potentially contributes to the failure of existing health programs involved in early stage prevention or intervention of dental caries, as observed by the results of SBBrasil, in wich 80% of the children at the age of 5 years with at least one cavitated lesion were not treated in 2003 and remained untreated in 2010[3,4].

To standardize the international studies of dental caries in various populations, the World Health Organization (WHO)[5] recommends using the criteria proposed by Klein et al.[6], which is the most frequently used criteria worldwide. The criteria are simple, presenting high reproducibility by detecting only the presence or absence of decayed, filled, and missing teeth. Nevertheless, the criteria do not detect the complexity of the disease or related treatment, which requires the use of additional instruments such as the pufa/PUFA (pulp involvement, ulceration, fistula, and abscess)[7] and the Treatment Need Index[8].

An instrument that has proven to be effective in assessing the prevalence and the different severity stages of dental caries is the Caries Assessment Spectrum and Treatment (CAST)[9]. It was proposed in 2011, validated in 2013 and has been proven to be easy-to-use, with its results easily communicated to health policy makers[10]. The full spectrum of disease is captured in this single instrument, with codes listed in hierarchical order that reveal additional complexities and suggest the need for treatment of the individual or the population as a whole. Through the instrument it is possible to calculate caries prevalence and to group individuals according to the disease severity[11]. Another distinguishing feature of the instrument is the grouping of codes according to dental health status as follows: healthy, pre-morbidity, morbidity, and severe morbidity and mortality[12].

Additionally, the conversion of CAST codes into the D (decayed), M (missing) and F (filling) components is possible (an essential characteristic for the implementation of a new dental caries detection instrument), as shown by de Souza et al.[13]. Whereas that for decades the DMF index was the most commonly used criteria worldwide, this conversion will be necessary and extremely important. In Brazil, for example, oral health surveys at the national level are conducted using the WHO criteria. Thus, this study aims to compare the presentation of results of an epidemiological survey in which CAST was used to those converted to the WHO criteria and to determine whether there is an association of visible plaque and gingival bleeding index with the occurrence of carious lesions.

Materials and methods

Clinical design and sample selection

A cross-sectional study was conducted to obtain the prevalence of dental caries in schoolchildren aged 6 to 8 years from Estrutural, an urban area of Brazil's Federal District; the region has 39,015 inhabitants and a monthly per capita income of 153 U$[14]. The study was approved by the Research Ethics Committee of the School of Health Sciences of the University of Brasilia and authorized by the Secretary of Education from the Federal District.

All children whose parents signed the informed consent form were included in this study. The sample of 680 children was obtained from two public schools. For those in need of dental treatment, simple procedures, such as restorations and sealants, were performed at schools; pulpectomies and tooth extractions were performed at the Pediatric Dentistry Clinic of the University Hospital of Brasilia (HUB).

Training and calibration

The clinical examination was performed by two examiners who were trained and calibrated in the use of the CAST instrument according to the instructions of the CAST manual[12]. Training included a theoretical 2-hour lecture taught by an experienced examiner and a practice session demonstrating the use of the CAST instrument in children at the Pediatric Dentistry Clinic of HUB. Then, the calibration was performed by examining children from the same age of those who would be included in the main study, but who did not take part of it. The calibration exercise was considerate concluded when adequate

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levels of intra- and inter-examiner correlation were achieved.

The intra- and inter-examiner correlation coefficients were calculated for 10% of the sample. The intra-examiner correlation was 0.79 for examiner 1 and 0.82 for examiner 2. Similarly, the inter-examiner correlation was 0.90. These kappa coefficient values, according to Landis and Koch[15], reflect a high level of correlation.

Data collection

The epidemiological survey included two stages for the collection of data: clinical examination and sociodemographic questionnaire completed by the parents.

During the clinical examination, the visible plaque index (VPI) and the gingival bleeding index (GBI) were recorded, along with the presence of dental caries using the CAST instrument.

Clinical examinations were carried out in an available schoolroom, using a portable bed, a desk, and artificial lighting. The VPI was evaluated by visual inspection of the buccal surfaces of all the teeth without use of dyes, according to the criteria of Alaluusua and Malmivirta[16]. For the GBI, a Community Periodontal Index (CPI) probe was used on the buccal surfaces of all the teeth, according to the criteria of Ainamo and Bay[17].

After the assessment of VPI and GBI, teeth were cleaned with a toothbrush, toothpaste, and dental floss by examiners. Using gauze and the CPI probe, the examiner evaluated the teeth, with the results recorded by a trained note-taker. A CAST code was assigned to the surface of each tooth. As described in the CAST manual12 and through clinical examination notes, a maximum CAST code per tooth and per individual were obtained. The CAST codes/tooth were converted into dmf/DMF components and the mean dmft/DMFT scores were calculated. The conversion was performed according to Souza et al.[13], in which CAST code 2 is considered restored (F/f), CAST codes 5-7 are decayed (D/d) and code 8 is lost due to caries (M/m).

The socio-demographic questionnaire was sent to parents, who replied to 15 questions about the family income and life style and parents' level of education.

Statistical analysis

Categorical variables were presented by absolute value and percentage. Clinical features (VPI, GBI, CAST maximum codes per tooth and per individual) and gender were compared using the statistical tests chi-square or Fisher. The calculation of the intra and inter-examiner correlation was made by Kappa.

To obtain the VPI and GBI scores, the ratio between the number of teeth with plaque and bleeding and number of teeth in the child's oral cavity was calculated. The logistic regression model was performed to calculate the odds ratio (OR) of variables VPI and GBI regarding the maximum CAST code per tooth and per individual, respectively. A p value less than 0.05 was considered to indicate statistical significance.

The statistical analysis was performed using STATA software, version 13.1 (College Station, TX, USA).

Results

Sample characterization

Six hundred and eighty children were examined, 337 (49.56%) were males and 343 females (50.44%). The mean age was 7.45 years (± 0.91). The distribution per school was as follows: 405 children in the first school (59.56%) and 275 children in the second one (40.44%).

The sample characterization according to socio-demographic variables is presented in Table 1. It was observed that the children are from low-income families and whose parents studied for an average of eight years or less. The response rate was of 72%.

Prevalence of dental caries and disease stages

Caries prevalence for the primary dentition using CAST was 51.76% (dentin carious lesions, CAST 4-7) and 65.44% (enamel + dentin carious lesions, CAST 3-7), respectively (Figure 1). Whereas the calculation of the prevalence of dental caries using the WHO criteria (CAST codes 2, 5, 6, 7, and 8) was 61.61%.

The prevalence of dentin carious lesions for the permanent dentition (CAST 4-7) was 10.82% as noted in Figure 1. By including carious lesions in both, enamel and dentin (CAST 3-7), the prevalence of the disease increased to 38.19%. Calculating the prevalence based on the WHO criteria (CAST 2, 5, 6, 7, and 8), the prevalence was 10.2%.

When grouping individuals by healthy dentition (CAST 0, 1, and 2), reversible pre-morbid-

Table 1. Characteristics of the families included in the study considering income, education level, and living conditions.

Criteria		Number (n)	Frequency (%)	Mean (± standard deviation)
Head of the household	Father	203	41.94	-
	Mother	216	44.63	-
	Grandfather or Grandmother	33	6.82	-
	Others	21	4.34	-
	No response	11	2.27	-
Years of study of the responsible	-	-	-	7.36 (± 3.16)
Years of study of the mother	-	-	-	8.12 (± 3.47)
Family income enough to cover basic expenses	No	228	47.11	-
	Yes	235	48.55	-
	No response	21	4.34	-
Number of people who live in the house	-	-	-	5.02 (± 1.9)
Number of rooms	-	-	-	2.41 (± 1.21)
Monthly family income*	< 1	200	41.32	-
	1 to 2	232	47.93	-
	2 to 3	38	7.85	-
	> 3	4	0.83	-
	No response	10	2.07	-

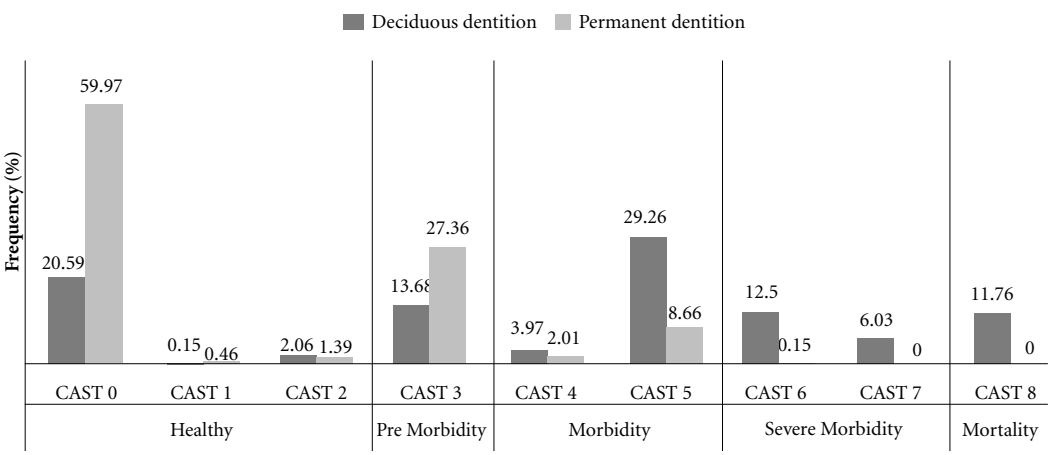

Figure 1. Distribution in percentage of maximum CAST score per individual in primary and permanent dentition, according to the level of dental disease.

ity stages (CAST 3), morbidity (CAST 4 and 5), severe morbidity (CAST 6 and 7), or mortality (CAST 8) as recommended by the CAST manual[12], it was observed that the percentage of individuals who were diseased overlapped with subjects who were healthy, a finding strongly correlated with a higher percentage of primary teeth affected by irreversible disease.

Score CAST per tooth and dmf/DMF components

The total number of assessed teeth was 15,118: 9,622 primary teeth and 5,496 permanent teeth. The examination was performed on all tooth surfaces, and 4 or 5 CAST codes per tooth were assigned given the number of evaluated surfaces.

The mean dmft obtained for this population was 2.4 (± 2.7), with a minimum value of 0 and a maximum of 17. The mean DMFT was 0.16 (± 0.53), with a minimum value of 0 and a maximum of 4.

When excluding CAST code 0, the most frequent CAST code for primary dentition was 5, whereas the most frequent CAST code for permanent teeth was 3 (Figure 2).

To compare the presentation of data using CAST codes versus the WHO criteria, the primary dentition was used as an example. For the dmf, separating the components into decayed, exfoliated, and filled, the data were as follows: 7,987 teeth were considered healthy (83.01%), 1,283 were considered decayed teeth (13.33%), 208 were restored, 12 had sealants (2.28%), and 132 teeth were lost/exfoliated (1.37%), as shown in Figure 3.

Hence, teeth considered decayed by CAST instrument (codes 3 and 4), are recorded as healthy when using the WHO criteria. In addition, teeth showing different stages of dental caries development in dentine are classified only as decayed using the WHO criteria, whereas using CAST instrument, it is possible to distinguish, for example, an injury with pulp involvement (CAST 6) from one with a fistula/abscess (CAST 7).

Visible Plaque Index, Gingival Bleeding Index, and association between CAST maximum scores per individual

The mean VPI and GBI were 0.52 (± 0.27) and 0.034 (± 0.07), respectively. A significant association of the presence of visible plaque with a higher maximum CAST score per individual was determined [1.34 (0.55 – 2.12), p = 0.001]; however, a similar association was not found with GBI [1.13 (-2.4 – 4.66), p = 0.532].

Discussion

CAST instrument and the WHO criteria differs in many aspects, including codes that register initial caries lesions, different dentine carious lesion stages and the way of presenting results. However, in the present investigation, the first major difference between CAST and WHO criteria observed was the calculation of the prevalence of dental caries. This has already been observed by de Souza et al.[13]. However, in that study, differently from the present investigation, the same children were seen twice in order to collect data through the WHO criteria and the CAST instrument. Herein, only CAST instrument was ap-

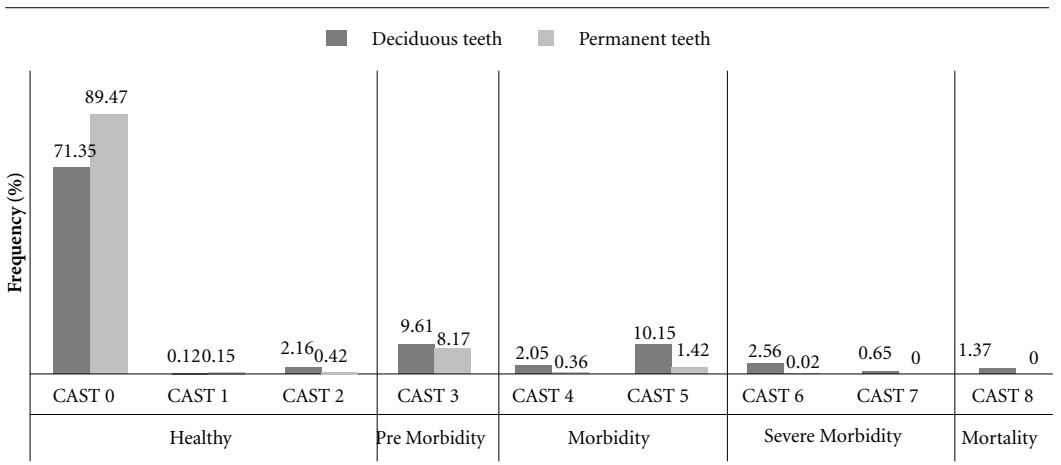

Figure 2. Frequency of maximum CAST codes per tooth of the primary and permanent dentition and the distribution by level of dental disease.

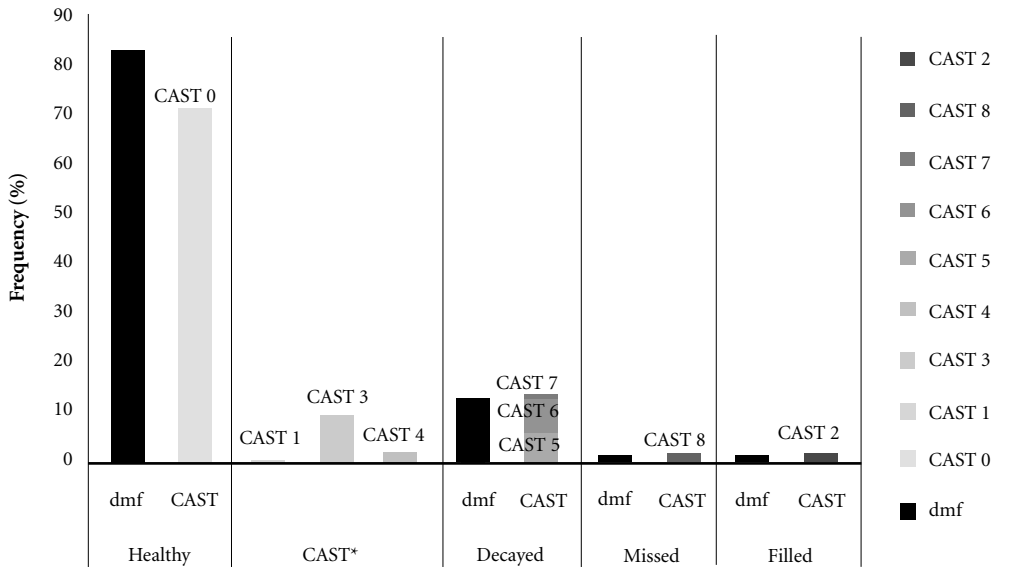

Figure 3. Frequency of dmf components for the primary dentition compared to the CAST presentation of data.

*do not present dmf correspondent.

plied, but an exercise to convert data into WHO criteria was made, aiming to show how that can be performed in future studies in which only the CAST instrument is used. Moreover the classification of the population in healthy and disease is presented, which was not covered by the study of Souza et al.[13].

Dental caries prevalence obtained by the CAST was 69.12%, considering teeth with enamel carious lesions (CAST 3), internal caries-discoloration in dentine (CAST 4), cavity in dentine (CAST 5), cavity with pulp exposure (CAST 6), and presence of fistula or abscess (CAST 7). When the prevalence is calculated according to the WHO criteria, CAST 3 and 4 are not included, as the dmft/DMFT does not cover these stages of the disease. However, the restored teeth (CAST 2) and lost due to caries (CAST 8) are counted. According to the CAST Manual12, it is not helpful to include CAST 2 and 8 in the calculation of the prevalence of dental caries, since these two conditions are related to the history of the disease[13]. For example, in an individual whose dmf/DMF is 2, and these two teeth are restored, there is no indication that the individual has dental caries. Hence, CAST offers a new method for analyzing and characterizing the prevalence of dental caries. In addition, it is possible to compare the data collected through the CAST instrument with previous data collected in studies using WHO criteria.

Considering the dental caries prevalence using the dmf/DMF components (62.93%), this value was higher than the prevalence of 37.2% found in the study by Martins et al.[18], which evaluated children between the ages of 8 and 10 years. This discrepancy may be due to a more heterogeneous sample in the study by Martins et al.[18], which included students from public and private schools. Another study of 12-year-old schoolchildren in Santa Maria (South of Brazil) also observed that children living in a low-income neighborhood had a higher chance of having untreated dental caries than residents in more affluent neighborhoods[19]. All the children included in our study were from public schools and resided in Estrutural, the lowest income area in the Federal District[19]. Overall, our results showed that 89.25% of the sample had a family income of up to two minimum wages, corroborating official data indicating a mean of 1.99 minimum wages as monthly household income for this region[19]. Additionally, 47.11% of respondents felt that the family income was not enough to cover basic household expenses. It was also noted that the head of the household and the child's mother

did not complete or only completed elementary school, respectively. Thus, the population included in this survey consists of individuals of Class D and E, occupying the lowest socioeconomic stratum according to the criteria "Brasil"[20]. Since the oral health status of children has been associated with social dimensions such as income and education level of their parents[21-23], both conditions may partially explain the prevalence of dental caries found and the population's lack of access to dental treatment.

Undoubtedly, one of the advantages of the WHO criteria is the final mean score obtained, which represents dental caries per individual or population. However, this score does not necessarily represent the severity of the disease, since the calculation includes restored teeth (without treatment needs). Therefore, the interpretation of this score requires a separate analysis of the dmf/DMF components. The CAST instrument does not provide a mean score, which initially may seem to be a disadvantage in relation to WHO criteria. However, it is possible to obtain the frequency of each of its codes by both the surface and the tooth. Considering the results of this research, it is clear that this population is significantly affected by dental disease, with about 37% of children requiring restorations and almost 19% of them already in need of more complex treatment.

In the analysis of the maximum CAST code for this population, CAST code 5 (30.88%) had the highest prevalence, whereas CAST codes 1 (0.29%) and 2 (1.76%) had the lowest prevalence. We inferred that the studied population does not have easy access to oral health care, which is expected in low-income populations[19]. In the data presented by SBBrasil 2010[4], the Brazilian population in general faces a real problem, since 80% of carious lesions in children aged 5 years remain untreated. With the emergence of the Smiling Brazil program[24], there has been an improvement in the oral health condition, especially when comparing the results of SBBrasil 2003[3] and 20104. Nevertheless, the children population needs to have a fast improvement, since 80% of carious lesions at 5 years of age in 2003 were not treated, and the same percentage was maintained in 2010.

Other variables that were also evaluated in this study were the VPI and GBI. We observed that the higher the maximum value of the individual CAST, the greater the VPI. This association can be confirmed in studies that evaluated risk factors for dental disease[25-27], a result already expected since it is known that dental caries is a biofilm-dependent disease. The same was not observed for the GBI. This was different from the study by Julihn et al.[27], who found a strong association between GBI and prevalence of dental caries ($p = 0.003$; OR 2.1). However, most studies show that there is a weak relationship between GBI and dental caries[26-29], the same result found in this study, which can be justified by the low GBI found in the population as a whole (mean of 0.034 per individual).

The limitations of this epidemiological survey, as with any large-sample study, include the difficulties in accessing the parents and/or guardians of the child. All contact was made by correspondence delivered by the child, as contact with the participants took place during school hours. Many of them would go to school unaccompanied by parents, using public transportation. This interfered with the collection of sociodemographic data, as our response rate was of 72%. The results of this study cannot be compared with those of previous studies because to date, there have been no oral health studies performed in Estrutural region.

Finally, the findings of the last National oral health survey[4] showed a disparity in caries prevalence among Brazilian population, but WHO criteria used in survey was not able to capture whether those who were considered caries free were really caries free; as the threshold used for registering dental caries is cavitation. Therefore, the surveys carried out by WHO criteria so far were able to portrait an overall scenario, but were not accurate in determining which are the actions needed to be implemented to control/treat the disease in the specific populations. Thus, it is believed that the use of a broader system to detect dental caries would better assist policy makers in designing preventive and interventional programs.

Conclusion

The way CAST results are presented showed a higher to identify the presence and severity of caries than in comparison in to the WHO criteria. Moreover, other clinical index, VPI was associated with higher CAST scores, while GBI showed no association.

Collaborations

IP Maciel performed dental examination, data collect, interpretation of results and script writing. APD Ribeiro performed dental examination, data collect, statistical analysis and interpretation of results. GA Pucca Júnior participated in script writing. A Bié converted CAST data to WHO criteria. SC Leal coordinated the study design, analysis and interpretation of data and performed the script writing.

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